this increase of volume for each degree of the F. scale it is inferred that the absolute zero is 460° F. below the ordinary zero. Logically this process is deficient in that it presupposes a known Fahrenheit scale; and there were just as many perfectly exact Fahrenheit scales as there were previously existing exactly made Fahrenheit thermometers. Our impression is that the law of Charles or Gay-Lussac expressed the fact that the different gases experimented on, all expanded by nearly the same fraction of their volume at the temperature of melting ice on being raised under constant pressure from that temperature to the "boiling point" of water. Then *this* expansion (from v_0 to v_{100} say) obtained accurately for any one gas enables t° C. to be *defined* for *that* gas as thermometric substance as that temperature for which the volume of the gas under constant pressure is $v_0 + t(v_{100} - v_0)/100$, and so also for the Fahrenheit scale. Taking air, we get by this definition the air thermometer scale, which, having its own independent definition, can be used as a standard of comparison for other thermometric scales.

From this we get the absolute zero on this gas thermometer scale as that for which $t = -100\,v_0/(v_{100} - v_0)$ that is for which the volume of the gas is zero. Fulfilment of Boyle's law, if it exists, gives agreement of the similarly, but independently, defined constant volume scale for the same gas with the constant pressure scale. Thus we get an independent scale for each gas for which accurate experimental data are available, and the *numerical reckoning* of the absolute zero of temperature will not be necessarily the same for all. We say this with Mr. Carter's note on p. 107 in view. We believe that a perfect gas is best defined as one which obeys Boyle's law at all pressures and temperatures, and gives a constant pressure scale agreeing with the only properly absolute scale of temperature, that of Lord Kelvin, or, which comes to the same thing, as a gas which, besides fulfilling Boyle's law, has an invariable ratio of specific heats.

The second law of thermodynamics is hardly that given on p. 106, which is really the so-called "axiom" on which Lord Kelvin based the second law. The law itself is most shortly expressed by the equation $\int dq/t = 0$, where t is absolute temperature, dq a quantity of heat taken in (or given out) at temperature t, and the integral is taken round a reversible cycle. If t_0 be the lowest available temperature, the positive value which $-t_0\int dq/t$ has for every non-reversible cycle is Lord Kelvin's expression for the heat dissipated in the cycle.

We are rather disappointed that no treatment, *e.g.* the beautiful graphical treatment given by Maxwell, is included of the thermodynamics of change of state. By means of the Protean fundamental parallelogram of the Carnot cycle, the whole of the essential part of thermodynamics can be given in two or three pages. A statement from this point of view of the information which thermodynamic theory gives as to the density of saturated steam would not have been inappropriate here.

The account of furnaces and boilers and of steam engines generally seems very full and complete, but a full review of it is a thing to be undertaken only by an expert in these matters. No one, however, who takes an interest in engineering methods and results, and nothing can be more valuable for the physicist than their study, can fail to be struck with the fulness of the information given by Mr. Carter.

In Part iii. gas and oil engines are discussed, and we have, after a chapter on gaseous and liquid fuel, the Otto cycle, and engines working on this cycle are fully described. This, to us, is perhaps the most interesting part of the book. Prime-movers of this description have advanced immensely during the last ten or twelve years, and the lot of those who have to use them is cast in much pleasanter places. We have a lively recollection of having to toil with five or six enthusiastic laboratory students turning the fly-wheel for nearly half an hour at a time trying to get a large gas engine started. This and other difficulties, and the continual setting to rights which the engine required, would have tried the patience of a saint, and certainly were too much for ordinary mortals.

In Part iv. water motors and turbines generally are discussed, in Part v. gearing is dealt with, and in Part vi. we have a most valuable account of types of power stations.

The book, it ought to be mentioned, is one of several excellent practical works that have appeared by instalments in the *Electrician*. It is very thoroughly illustrated with excellent drawings: engines of all kinds, central power stations, details of machinery, such as valve gear, governors, injectors, &c. Some of these might perhaps have been worked up better, but most are good, and all are thoroughly business-like and intelligible. We regret that we have not space to deal with the work more adequately; but as it is, in fact, a collection of some three or four separate treatises of great value, any attempt to fully review it here is impossible.

We have nothing but congratulation for the author on his work. Electrical engineers are deeply in his debt.

A. GRAY.

A PIONEER OF MEDICINE.

Masters of Medicine. John Hunter, Man of Science and Surgeon. By Stephen Paget, with an introduction by Sir James Paget. 8vo. Pp. 272, with a frontispiece. (London: T. Fisher Unwin, 1897.)

MR. FISHER UNWIN has undertaken to publish a series of volumes dealing with the life and works of the great scientific men who have brought medicine and the allied sciences to their present state of perfection. The object of the series, which is under the general editorship of Mr. Ernest Hart, editor of the *British Medical Journal*, is to set before unprofessional readers a plain account of the lives and fortunes of the "Masters of Medicine," with such a survey of their work as may be necessary to show wherein they excelled.

John Hunter lends himself particularly to this method of treatment. Living only a hundred years ago, the founder of a great school of thought, the hero of a hundred orations by the most eminent surgical minds of the century, there exists plenty of material from which to construct a most readable biography. His life, indeed, has often been written but not always judiciously, for it

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is only of late years that the critical spirit, which has reduced the writing of history to a science, has begun to pervade the historians of medicine. Mr. Paget has performed his work excellently, for he has consulted original authorities and has availed himself, by the kindness of Miss Hunter-Baillie, of such documents belonging to the Hunter family as are now in her possession. Fresh light is thus thrown upon some of the more obscure points in Hunter's career, whilst the charming personality of Mrs. Hunter, who selected the words for Haydn's Creation, is brought into bolder relief.

John Hunter, the founder of pathology, or the science which deals with the causes and progress of disease, was one of the younger members of a very remarkable band of pioneers in medicine who were born within a few miles of each other in a remote country district of Scotland, and who flourished in the middle of the last century. First in seniority was Smellie, of Lanark, the great man-midwife; then Cullen, sometime professor of medicine in Edinburgh, born at Hamilton; after him came William Hunter, in some respects greater even than John, his youngest brother; and finally Matthew Baillie, nephew of the Hunters, and the most worthy disciple of his uncles. Smollett, too, was the intimate friend of Smellie, and so must have known the Hunters. It would be of extreme interest to know the factors which led to the production of such extraordinary talent in so circumscribed an area and for so limited a period. In the Hunter family no less than three sons of the ten children were extraordinarily gifted, and in each case their genius was directed towards medical science. That the genius was innate is clearly shown by the fact that John Hunter instantly became an accomplished anatomist, and that although he was an original thinker of the highest power, he was in many respects illiterate, and always had the greatest difficulty in expressing his thoughts in words. Beginning with nothing, John Hunter, after many years of struggle, achieved a foremost place amongst the surgeons of London. But it was by his teaching, rather than by his clinical powers, that he gained his reputation. Edward Jenner, in England, the discoverer of vaccination, and Dr. Physick, who lived to become the veteran exponent of his master's teaching in America, were amongst his house pupils, whilst all the foremost surgeons of the next generation had attended his lectures—lectures which cost his hearers but tenpence a-piece, as Mr. Paget points out, for they were near a hundred in number, the honorarium for the course being four guineas. Yet the lectures were of the most magnificent kind, for they comprehended the whole circle of the sciences round surgery. They were made at a great cost to Hunter, for his brother-in-law, (Sir) Everard Home says of them:

> "Giving lectures was always particularly unpleasant to him; so that the desire of submitting his opinions to the world, and learning their general estimation, was scarcely sufficient to overcome his natural dislike to speaking in public. He never gave the first lecture of his course without taking thirty drops of laudanum to take off the effects of his uneasiness. He was so diffident of himself that he trusted nothing to memory, and made me draw up a short abstract of each lecture, which he read on the following evening as a recapitulation to connect the subject in the minds of the students."

It is no wonder, therefore, that the toils of his practice, the cares attending the amassing of the nucleus of the magnificent museum now housed in Lincoln's Inn Fields, and the labours of teaching, early overweighted a body by no means strong. He suffered from angina pectoris for many years before his death, and was wont to say that his life was at the mercy of any rascal who chose to irritate him, and he was very irritable. He died suddenly at St. George's Hospital, October 16, 1793, on the same day, and perhaps at the same hour, that the unfortunate Marie Antoinette, Queen of France, was beheaded in Paris. He was buried in the vault of St. Martin's-in-the-Fields, whence the pious care of Frank Buckland rescued his remains in 1859, and they were re-interred in Westminster Abbey.

Mr. Paget has performed his task most excellently, and if the present volume is to be taken as a standard for the series the sale should be large. Not only is the book well and pleasantly written, abounding in anecdote, but it is most tastefully produced, so that the paper, the print, the binding, and the reproduction of a part of Sir Joshua Reynolds' portrait of Hunter are in every way admirable.

SELECTIONS FROM A DIARY.

The Journals of Walter White, Assistant Secretary of the Royal Society. With a preface by his brother, William White. Pp. vii + 285. (London: Chapman and Hall, Ltd., 1898.)

MOST of the Fellows of the Royal Society of more than twelve years' standing will retain a lively recollection of Mr. Walter White, whilom Assistant Secretary to the Society, and will look with interest into the present volume. Mr. White entered the service of the Royal Society in 1844, and in 1861 (not, as incorrectly stated in the preface, in 1853, "less than ten years") was appointed Assistant Secretary, which office he held until 1885. During this long period he had unusual opportunities of watching the inner working of the Society, and thus the development of scientific ideas and activities; and the reader of the diary of so shrewd and observant man as he was, would naturally expect to learn much. We are compelled to say at once that such expectations will not be fulfilled.

The first chapter, which contains entries in the diary up to the time of his attaining a post at the Royal Society, is interesting as showing how a man, brought up as a cabinet-maker, after pursuing diligently his trade for some years, by continued intellectual toil, bravely teaching himself, won his way, amid many discouraging circumstances, to a means of livelihood more congenial to his nature. It will probably surprise many of the Fellows of the Royal Society to learn that one whose great knowledge of languages and literature had often been of help to them, had spent so many of his earlier years at the joiner's bench.

The third chapter puts together a number of entries illustrating Mr. Walter White's intimacy with the late Lord Tennyson. From one of these entries we gather that it was a suggestion from Mr. Walter White which led the poet eventually to build a house at Haslemere.

The second and fourth chapters contain, together with

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